Nat 5: Unit 1 Chemical Changes and Structure

Key Area: Bonding Related to Properties of Materials

Lesson 23: Covalent Bonding

Learning Outcomes

By the end of the lesson you should …

1. Be aware that oxygen and nitrogen contain multiple covalent bonds
2. Be able to state what a diatomic molecule is.
3. Be able to link the number of covalent bonds to the shape of a molecule.

Success Criteria

You will have been successful in this lesson if you:

1. Successfully complete all self checks evaluating and correcting any errors made.
2. Be able to state the 7 diatomic molecules.
3. Be able to state and draw the shape of simple molecules.
4. Complete Homework 8

If you have any questions about the content of this lesson, you should ask your **class teacher** either through your class MS team or via email. MS Teams will be monitored throughout the week by a chemistry teacher. If you need help or clarification with either the task or the content of the lesson, just ask.

Links to Prior Knowledge:

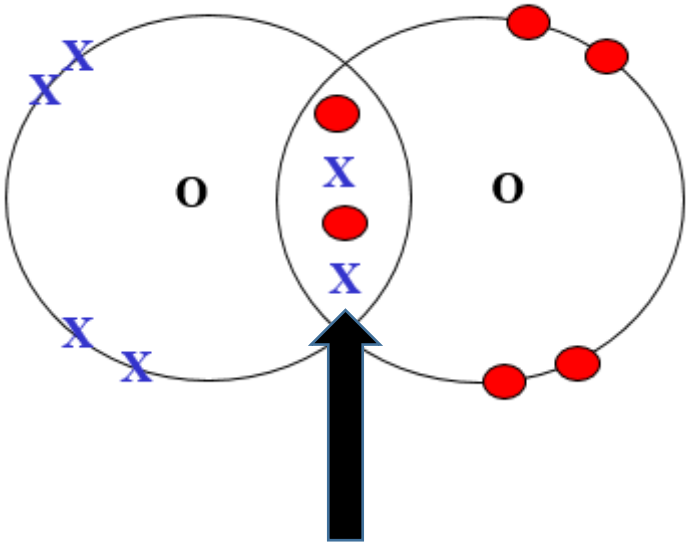
Atomic structure, naming compounds and valency.

You may wish to have a copy of the data booklet handy for this lesson.
Download from the SQA website - ChemistryDataBookletSQPN5.pdf (sqa.org.uk)

Special Cases

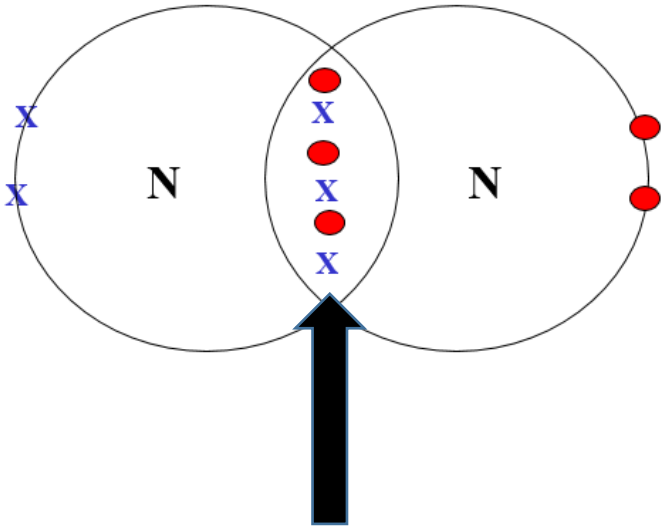
Oxygen and Nitrogen are special cases because they contain **multiple covalent bonds**.

An oxygen molecule (O_2) is held together by a double covalent bond:



4 electrons in overlap representing
a **double covalent bond**

A nitrogen molecule (N_2) is held together by a **triple covalent bond**:



6 electrons in overlap representing
a **triple covalent bond**

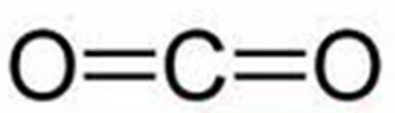
Molecules

Most Covalent substances are made up of **molecules**.

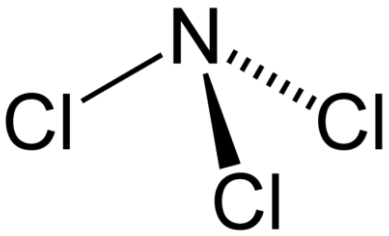
Molecules contain **2 or more non-metal** atoms held together by covalent bonds.

e.g.

carbon dioxide



Nitrogen chloride



Diatomic Molecules

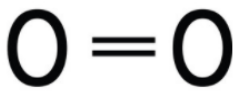
These are molecules that contain a total of **2 atoms only.**

The Diatomic Elements:

e.g.

Chlorine

Oxygen



Nitrogen

As can be seen from the above

a chlorine molecule is held together by a single covalent bond
an oxygen molecule is held together by a double covalent bond
a nitrogen molecule is held together by a triple covalent bond

A total of **7 elements** exist as diatomic molecules and **should be learned**:

Hydrogen	H_2	Flourine	F_2	Iodine I_2
Nitrogen	N_2	Chlorine	Cl_2	
Oxygen	O_2	Bromine	Br_2	

Diatomic Compounds

These compounds will contain a **total of 2 different non-metal elements**:

Hydrogen chloride (HCl)

Carbon monoxide (CO)

Water (H_2O) is **not diatomic,** it contains 2 different elements but a total of 3 atoms.

Shapes of Covalent Molecules

The **shape** of simple covalent molecules depends on

1. the **number of covalent bonds** and

2. the way they are arranged around the central atom

There are 4 shapes:

1. Linear
2. Angular
3. Trigonal pyramidal
4. Tetrahedral

You must be able to **recognise or draw** all of these shapes.

1. Linear

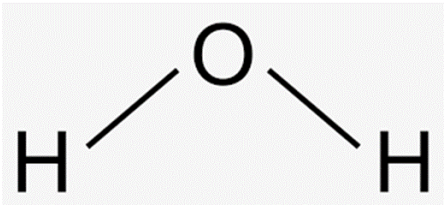
Any molecule that contains only **1 bond** will have a linear shape.

e.g. H_2, F_2, HCl

2. Angular

Any molecule that contains **2 bonds** will have an angular shape.

e.g. SCl_2, SeF_2, H_2O

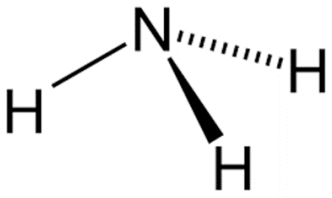


The bonds must be coming down at an angle. **Never straight out**.

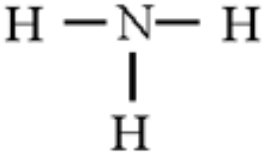
3. Trigonal pyramidal

Any molecule that contains **3 bonds** will have a trigonal pyramidal shape.

e.g. PCl_3, $AsBr_3$, NH_3



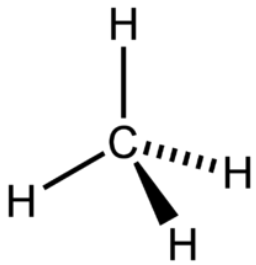
Bonds must be coming down at an angle. Never straight out.

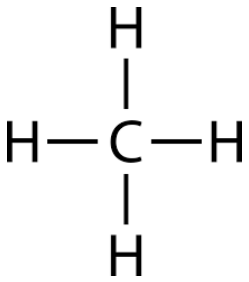


4. Tetrahedral

Any molecule that contains **4 bonds** will have a tetrahedral shape.

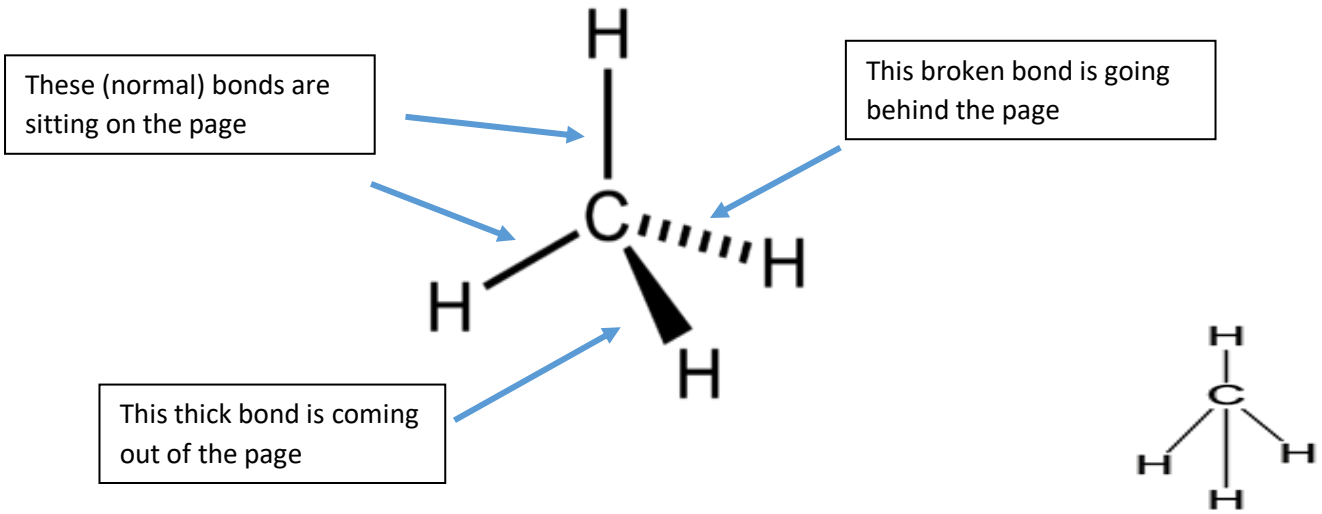
e.g. CCl_4, $SiBr_4$, CH_4





Explanation of Strange Looking Bonds

The broken and thick covalent bonds are **not required** when you draw the shape, they are only there to provide a 3d impression. All normal bonds are easier to draw and are acceptable.



Practice Makes Perfect

Once you have read and fully understand the previous information please attempt the following self checks in your jotter.

Self Check 21

1. Draw and name the **shape** of the following molecules:

(a) Silicon hydride (SiH_4)
(b) Water (H_2O)
(c) Nitrogen chloride (NCl_3)
d) Iodine (I_2)

2. Which of the elements below exist as diatomic molecules?

(a) hydrogen
(b) chlorine
(c) neon
(d) magnesium
(e) sulphur
(f) bromine
(g) carbon
(h) fluorine
(i) iron
(j) oxygen
(k) nitrogen
(l) iodine

3. The compounds listed below are all made of molecules. For each compound state whether or not the molecule is diatomic.
(use valency to work out formula first!)

(a) carbon iodide
(b) selenium sulfide
(c) hydrogen bromide
(d) chlorine oxide
(e) Arsenic chloride
(f) boron nitride

4. Draw and name the **shape** of the following molecules formed when the elements react together:
(use valency to work out formula first!)

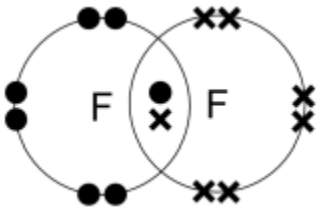
(a) Selenium fluoride
(b) Hydrogen bromide
(c) Phosphorous hydride
(d) Carbon chloride

Homework 9

1. For each of the compounds below state whether the compound is covalent or ionic.

(a)	$CaCl_2$	(b)	SiF_4
(c)	Na_20	(d)	Al_2O_3
(e)	SCl_2	(f)	CCl_4
(g)	K_2Se	(h)	PN

2. Fluorine gas exists as molecules which contain two fluorine atoms. The diagram below shows a molecule of fluorine.



(a) What name is given to a molecule which contains two atoms?
(b) Name three other **elements** which are made up from molecules which contain only two atoms.
(c) Why do the fluorine atoms share electrons?
(d) The 2 atoms are held together by a covalent bond. What is a covalent bond?

3. For each of the compounds below:

i. Draw a diagram to show how outer electrons are shared to form the covalent bonds in the molecule.

ii. Draw a diagram showing the shape of the molecule.

iii. Name the shape of each molecule

(a)	PF_3	(b)	H_2S
(c)	$SiBr_4$	(d)	HCl